


Artigo

Effect of the Plastic Cover on the Productivity and Profitability of Vineyard in the São Francisco River Valley, Brazil

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Abstract

Data from field experiments conducted in vineyards table grape variety of *Festival* in Petrolina-PE, from October/2009 to November/2010, were used to evaluate the influence of the plastic cover on productivity and economic profitability of the viticulture in the São Francisco River Valley. Three treatments were studied: uncovered canopy (UC), plastic cover placed at 50 cm above the canopy (PC50), and a plastic cover placed at 100 cm above the canopy (PC100). The results indicated that the increased supply of radiative fluxes at the height of the berries in the treatment PC100 contributed to higher productivity, while treatment PC50 had the lowest offer of irradiative fluxes at the height of berries and much lower productivity. The yield obtained in the treatment PC100 exceeded 11 t ha⁻¹ and 12.3 t ha⁻¹ to those of treatments at UC and PC50, respectively. Treatment PC100 also had the lowest amounts of defects of berries, which contributed to higher total revenue. By contrast, treatment PC50 had markedly lower productivity, which represented considerable economic losses.

Keywords: *Vitis vinifera* L., variety *Festival*, table grape, physical and commercial productivity, benefit/cost ratio.

Efeito da Cobertura Plástica na Produtividade e Rentabilidade de Parreirais na Região do Vale do São Francisco

Resumo

Dados de experimentos de campo conduzidos em parreirais de uva de mesa da variedade *Festival*, em Petrolina-PE, no período de outubro/2009 a novembro/2010, foram usados para avaliar a influência da cobertura plástica sobre o microclima, produtividade e impacto econômico de parreirais. Foram estudados três tratamentos: sem cobertura (SC); com cobertura plástica posicionada a 50 cm acima do dossel (CP50); e com cobertura plástica posicionada a 100 cm acima do dossel (CP100). Os resultados indicaram que a maior oferta de fluxos radiativos na altura das bagas no tratamento CP100 contribuiu para uma maior produtividade, enquanto que o tratamento CP50 teve a menor oferta de fluxos radiativos na altura das bagas e uma produtividade bem menor. A produtividade obtida no tratamento CP100 superou em 11 t ha⁻¹ àquela do tratamento SC e em 12,3 t ha⁻¹ a do tratamento CP50. O tratamento CP100, também foi o que apresentou as menores quantidades de defeitos graves e leves, o que contribuiu para uma maior receita total. Em contra partida, o tratamento CP50 teve uma produtividade acentuadamente menor, o que representou prejuízos econômicos consideráveis.

Palavras-chave: *Vitis vinifera* L., variedade *Festival*, uva de mesa, produtividade física e comercial, relação benefício/custo.

1. Introduction

Grape is one of the fruits that have been most prominent in the semiarid region of São Francisco River Valley (SFRV), Northeast of Brazil (NEB), with increasing export volume (Hirsch, 2005). It is highly demanded by European countries and the United States, motivating exporters to invest in the expansion of cultivated areas and employment of technology, crop management, and packaging. Since the prices obtained in the foreign market are superior to those of the domestic market, guaranteeing higher economic profitability to the activity. Thus, the requirements of the producers, the new conditions, and the prospecting of new demands have been successfully adapted to the market in which they operate (Vitti *et al.*, 2008).

The support of Brazil's insertion in the international market of table grapes is exclusively attributed to the increase of its cultivation, following technological standards of high technical and economic efficiency from the production phase to the processing and marketing. These procedures make the quality of the grape compatible, cost of production, and sales price at levels satisfactory to the maintenance of the competitiveness of the activity (Araujo and Correia, 2006). The table grape growth also plays an important social role in the region (SFRV) and generates labor occupation in the ratio of 5 men day⁻¹ ha⁻¹ (Azevedo *et al.*, 2012). It is composed mostly of women given the specificities of management operations in the field phase and the improvement of products that require specific manual skills and high concentration.

The semi-arid climate of the SFRV guarantees a high competitive differential to the other grape-producing regions of Brazil since it presents stable conditions throughout the year and allows the harvesting of up to three annual crops, whereas irrigation is used (Hirsch, 2005). In the region, the production system is planned to harvest during the periods from April to June and from October to December, when major market windows occur in importing countries, mainly in Europe and the United States (Vitti *et al.*, 2008).

The protected cultivation of the grape, like other crops, is used worldwide, mainly in European countries of the Mediterranean region (Rana *et al.*, 2004; Leitão *et al.*, 2017). In general, the plastic cover is used for improving the thermo-hygrometric conditions when the atmospheric conditions are unfavorable to the plant growth and development, mostly adverse weather parameters, such as radiation, temperature, wind, and precipitation (Olmstead *et al.*, 2001; Silva *et al.*, 2011b). In Brazil, the plastic cover of vineyards was introduced to the State of Rio Grande do Sul, which has a cold climate with rainfall, strong winds, and hail at the time of grape maturation. These conditions can cause cracks and diseases (Santos *et al.*, 2004; Chavarria *et al.*, 2007, 2009; Leitão *et al.*, 2017). The plastic cover has also been employed in other

States, such as the State of Paraná (Genta *et al.*, 2010) and the State of São Paulo (Lulu *et al.*, 2005; Pedro Jr. *et al.*, 2007; Colombo *et al.*, 2011).

Since 2004, the use of plastic covering arose from the need to use a protective mechanism against the installation of fungal diseases, which began to occur in the vineyards of the São Francisco Valley region. However, the phenomenon of splitting of some varieties of grape berries before or during harvesting has occurred in specific locations, associated to the occurrence of intense rainfall, high temperatures and low incidence of solar radiation (Palma *et al.*, 1999; Vieira *et al.*, 2008). According to Silva *et al.* (2011) and Leitão *et al.* (2017), the plastic cover provides a significant increase in air temperature on the canopy and acts as a physical barrier to the air movement.

Therefore, due to the strategic economic and social importance of the vineyards for the region, the plastic cover has been considered and recognized in studies on sustainability and competitiveness of table grape growth as an essential mechanism that must be improved. Thus, this study aimed to study the influence of the plastic cover on productivity and economic profitability of vineyard in the SFRV region, assessing the effects of the height of the plastic cover on the microclimate and productivity of vineyards and the loss caused by defects in the berries.

2. Material and Methods

2.1. Experimental area

The research was conducted in a vineyard of the table grape variety *superior seedless*, *seedless Festival* or simply *Festival* on the Águia do Vale Farm (9°6'14" S, 40°29'52" W; 360 m), located in the Irrigation Project "Maria Teresa", Petrolina City - Pernambuco State throughout the phenological phases of maturation and harvesting for the period from September 19 to October 12, 2010. The vineyards were conducted in the trellis system and planting on 0.5 m height ridges and planting spacing of 3.5 x 2.0 m, as described in Leitão *et al.* (2017). It was used a plastic cover of low-density polyethylene (LDPE) film, 160 mm thick, transparent and 3 m wide. The irrigation system used in the vineyard was drip irrigation, with the application of weekly irrigation depth obtained to the flow of the irrigation system (2.67 mm h⁻¹), based on crop coefficient ($K_c = 0.8$) and reference evapotranspiration (ET_0 , in mm) obtained from the weather station in Timbaúba Farm, located 13 km away from the experimental area, and the local rainfall ($R = 777.2$ mm year⁻¹).

Each plot consisted of three rows of plants, two of them covered with the same clear plastic used by producers in the region, willing and fixed on the canopy trellis in chapel format. The period of vineyard coverage occurred during the stages of maturation and grape harvest, as is

traditionally done by local farmers. Field experiments were conducted in three treatments: uncovered canopy (UC), a plastic cover positioned at 50 cm above the canopy (PC50), and a plastic cover placed at 100 cm above the canopy (PC100). The early harvest was determined following the schedule established by the management of property that took as parameters the market demand and the minimum level of concentration in the berries soluble solids content (Brix \geq 14%). It was reviewed regularly during cultivation both in the laboratory of producer's cooperative as in own vineyard with a digital refractometer (ATAGO, model PAL-1 Digital Pocket Refractometer, USA).

The climatic conditions were monitored through the following instruments: air temperature sensors (HMP45, Campbell Scientific, Logan-UT, USA), psychrometers (Vaisala, Helsinki, Finland), anemometers (R. M. Young, Traverse, Michigan, USA), net radiometers (CNR1, Kipp & Zonen, Logan-UT, USA), photosynthetically active radiation (PAR), Eppley Precision Spectral Pyranometer (PSP) (Eppley, Newport, RI, USA), equipped with solar filters (Eppley, Newport, RI, USA) and pluviometer (Tipping Bucket Rain Gauges, Texas Electronics, Dallas-TX, USA). All these sensors were connected to automatic data acquisition systems (CR23X and CR1000, Campbell Scientific, Logan-UT, USA), programmed to perform readings every 2 seconds, generate hourly and daily averages and daily extreme values (Azevedo *et al.*, 2012; Leitão *et al.*, 2017).

2.2. Methodology

The net radiation (R_n) is given by the sum of the shortwave and longwave radiation balances, based on the Eq. (1) (Leitão *et al.*, 2017):

$$R_n = (K\downarrow - K\uparrow) + (L\downarrow - L\uparrow) \quad (1)$$

where $K\downarrow$ is incident shortwave radiation; $K\uparrow$ is the reflected shortwave radiation; $L\downarrow$ is the long-wave radiation that arrives on the canopy emitted by the plastic cover and/or atmosphere, and $L\uparrow$ is the longwave radiation emitted by the canopy surface. All components of the radiation balance were measured with the CNR1.

Productivity (P) was obtained, taking as a reference an estimated population of plants by 1 ha, as follows:

$$P = n_p \cdot P_p \quad (2)$$

where n_p is the number of plants per hectare, and P_p is the physical productivity obtained as the weight of bunches and loose berries of each plant.

Statistical analysis of productivity data for each treatment was performed using the SAS (Statistical Analysis System) software, from the determination of the standard deviation about the arithmetic mean of the

obtained values. This measure provides an estimate of the degree of precision of the estimated average data. Thus, the average standard error was used as the measure for comparison of treatment, given by:

$$s = \sqrt{\frac{SSD}{N - i}} \quad (3)$$

where s is the standard deviation, SSD the sum of squares of differences and N the number of observations.

Financial income (F_i) was determined considering two different marketing scenarios:

Scenario 1: When the beneficiation operations fully complied with the technical regulation of identity and grape quality, regarding the elimination of severe and minor defects, as recommended by the Normative Instruction n° 1 of February 1st, 2002 (Brazil, 2002);

Scenario 2: When the bunches with defects (immature grapes rot on stems and profound damage) were taken to be marketed in a transparent plastic bag of 500 g called "begging bowl" very commercialized in the European market.

This form of market production, unlike packages of 5 kg boxes, enables even bunches defects can be partially recovered by removing the portion with the imperfection of the bunches to minimize losses caused by climate and phytosanitary variations that interfere with harnessing the productivity of vineyards:

$$F_i = p \cdot q \quad (4)$$

where p (R\$ kg⁻¹) is the average annual price and q (kg) the quantities of grapes marketed effectively.

The economic evaluation of the results was obtained, considering the calculation of total revenue based on physical production, which made it possible that the number of defective grapes was quantified monetarily and its corporate impact on the economic analysis. From comparisons of total revenue, total cost, and economic productivity, the following indexes of economic efficiency were obtained:

– *Benefit/cost relation* ($R_{B/C}$):

$$R_{B/C} = \frac{R_t}{C_t} \quad (5)$$

where R_t is the total revenue (R\$) and C_t the total annual cost of the grape variety *Festival* (R\$) provided by the owner of the property that hosted the experiments, converted to cost per hectare.

– Point leveling or balance (P_n):

$$P_n = \frac{C_t}{P_s} \quad (6)$$

where P_s is the annual average value of the sale and the margin of safety (M_s) given as:

$$M_s = \frac{(C_t - R_t)}{R_t} \quad (7)$$

3. Results and Discussion

The data presented in Table 1 indicate that, under the canopy, the lower values of radiative fluxes (Rn and PAR) and productivity (P) occurred in the PC50 treatment. This is associated with the climatic conditions generated by the plastic cover positioned at a shorter distance above the canopy, which contributed to the reduction of short-wave radiation, net radiation and particularly of photosynthetically active radiation (Amarante *et al.*, 2007; Conceição and Marin, 2009; Mota *et al.*, 2009; Cardoso *et al.*,

Table 1 - Average daily of net radiation (Rn), photosynthetically active radiation (PAR), observed for the grapes variety *Festival* under the following treatments: uncovered canopy (UC); a plastic cover positioned at 50 cm above the canopy (PC50); and a plastic cover placed at 100 cm above the canopy (PC100) throughout maturation and harvest; leaf area index (LAI) and productivity (P).

Treatment	First experiment (2009)			
	Rn (W m ⁻²)	PAR (W m ⁻²)	LAI (m ² m ⁻²)	P (t ha ⁻¹)
UC	29.1	23.1	8.5	26.8
PC50	23.7	18.8	6.6	9.8
PC100	25.2	20.8	6.8	26.4
Treatment	Second experiment (2010)			
	Rn (W m ⁻²)	PAR (W m ⁻²)	LAI (m ² m ⁻²)	P (t ha ⁻¹)
UC	60.1	35.1	6.6	19.1
PC50	38.0	20.7	5.9	17.8
PC100	109.2	58.9	3.8	30.1

Table 2 - Physical and commercial productivity and discarded grapes from vineyards with uncovered canopy (UC); a plastic cover positioned at 50 cm above the canopy (PC50); and a plastic cover placed at 100 cm above the canopy (PC100) treatments, in the municipality of Petrolina-PE.

Treatment	Productivity (t ha ⁻¹)							
	First experiment (2009)			Second experiment (2010)				
	Physical	Commercial	Discarded (*)	Physical	Commercial		Discarded (*)	
					Scenario 1 (*)	Scenario 2 (**)	Bunch	Bulk
UC	26.8	24.2	2.4	19.0	15.6	16.7	1.1	2.3
PC50	9.8	9.4	0.4	17.8	15.4	16.3	0.9	1.5
PC100	26.4	25.2	1.1	30.9	27.0	28.0	1.1	2.8

*Total elimination of grapes with severe defects (cracked and berry stems with a disease); **Partial removal of grapes with a severe defect, taking advantage of the composition in 1 kg packs, not observing the Normative Instruction n° 1 of February 1st, 2002 (Brazil, 2002).

2010; Comiran *et al.*, 2012; Leitão *et al.*, 2017). As a result, there was a marked reduction in productivity. On the other hand, the higher values of radiative fluxes in 2009 took place in the UC treatment, which had the highest P (26.8 t ha⁻¹), followed closely by PC100 treatment (26.4 t ha⁻¹). However, in 2010, the values of radiative fluxes observed to PC100 treatment, and P were much higher than in other treatments. The production obtained in PC100 treatment exceeded 11 t ha⁻¹ that of UC treatment and 12.3 t ha⁻¹ at the PC50 treatments. These results show that the increased supply of radiative fluxes in the PC100 treatment contributed to increasing P . This fact reinforces the idea that, in the region of the SFRV, the height of the plastic cover is critical to generating favorable microclimate conditions for the table grape vegetative growth and productivity. However, the PC50 is traditionally used in the region, contributing to a significant reduction in productivity and considerable economic damage to producers.

3.1. Productivity analysis

The average values of physical, marketable, and discarded productivities are shown in Table 2. The first experimental campaign (2009) revealed that the PC50 treatment had the lowest physical productivity (9.8 t ha⁻¹) and commercial productivity (9.4 t ha⁻¹), which is equivalent to about one-third of the productivity of the other procedures. The UC treatment showed higher physical productivity (26.8 t ha⁻¹), the second most considerable commercial productivity (24.2 t ha⁻¹) and the highest discarded productivity (2.4 t ha⁻¹). These results indicate that the change in the microclimate caused by the height of the plastic cover above the canopy has generated variations in physical productivity and the occurrence of defects in bunches and berries, influencing the marketable product. In the second experimental campaign (2010), the highest grape physical productivity was found to the PC100 treatment (30.9 t ha⁻¹), followed by UC (19.0 t ha⁻¹) and PC50 (17.8 t ha⁻¹) treatments (Table 2), respectively. However, when considering economic productivity (scenario 1) due

to a significant increase in bulk berries, the difference between it and the UC and PC50 treatments increases to 42.2% and 42.9%, respectively.

The highest difference in discarded productivity was recorded in the form of bulk, while in bunches mode values were nearly identical. The PC100 treatment showed the most substantial amount (bunch + bulk) discarded productivity (3.9 t ha⁻¹), followed by UC (3.4 t ha⁻¹) and the PC50 (2.4 t ha⁻¹) (Tables 2 and 3). The impact of these losses on commercial productivity was higher in scenario 1 conditions. Thus, the average physical productivity of PC100 treatment (30.9 t ha⁻¹) was statistically more significant than that from the other treatments (UC and PC50), which were not statistically different from each other. This result makes it possible to infer that in the PC100 treatment, the height of the plastic cover above canopy positively influenced the physical productivity, and significantly increased the production, compared to UC and PC50 treatments. It should be mentioned that in both scenarios, the average values of commercial products are the most critical focus of the assessments, and they represent the commercial terms grape compatible with Normative Instruction n° 1 of February 1st, 2002 (Brazil, 2002). The performances regarding the productivity of the treatments covered in the two experimental campaigns indicate that the PC100 treatment had much higher productivity than the PC50 treatment. Therefore, the height of the plastic cover on the vineyard canopy influenced both in physical productivity as ruled in quantity as well as directly to the economic production.

3.2. Economic profitability

The evaluation of the economic cost-effectiveness of *Festival* grape cultivation for both experimental campaigns is shown in Tables 3 and 4. Revenue amounts are

derived from the marketing of products as it occurs, where the owner is paid based on the average annual price of one kilogram of grape in the corresponding market (national or international). The physical production refers to the physiological production of the plant which, after having benefited from the elimination of severe and minor defects, is marketed in specific markets according to its standard: grapes without defects are exported or marketed in the national market in supermarket chains, and the local vinegar industry or peddlers purchase defective grapes.

The average annual price of 1 kg of grapes in the domestic or international market of R\$ 4.00 and the grapes sold under vineyards industrial and local fairground R\$ 0.30. Prices reported by the Agricultural Cooperative of Juazeiro-BA - ACJ.

It is observed in Table 3 that in the first experimental campaign (2009), the highest total revenue (R\$ 101,344.00) was generated by PC100 treatment and the lowest (R\$ 37,656.00) for the PC50 treatment. The UC treatment, although it had a slightly higher physical productivity (26.8 t ha⁻¹) against (26.4 t ha⁻¹) in the PC100, and had a total revenue (R\$ 97,670.00) which is 3.6% lower. It has resulted in the difference between the volumes marketed in the vinegar industry and peddlers (2.4 t ha⁻¹) to (1.1 t ha⁻¹) in the UC and PC100 treatment (Table 3), respectively. In the second experimental campaign (2010), for the marketing scenario 1, the highest revenue collected (R\$ 100,967.00) was also obtained in PC100 treatment. The UC and PC50 treatments showed smaller and slightly revenue differences from each other R \$ 58,596.00 and R\$ 57,628.00, respectively. It is also observed that most revenues for the PC100 treatment resulted significantly from its higher physical productivity (30.9 t ha⁻¹) against UC (18.9 t ha⁻¹) and PC50 (17.8 t ha⁻¹) treatments (Tables 3 and 4), respectively. Proportionally, there was also a smaller number of defects in the PC100

Table 3 - Physical productivity (P_p), commercial productivity (P_c) for internal/external markets ($M_{i/e}$) and industry/peddlers ($M_{i/p}$) and total revenue (R_t) grape variety *Festival* estimated by hectare for uncovered treatment (UC) and covered with plastic (PC50) and (PC100), harvested in the falls of 2009 and 2010, in Petrolina-PE.

Treatment	First experiment (2009)					
	P_p (t ha ⁻¹)	P_c (t ha ⁻¹)		R_t (R\$ 1,00)		Total
		$M_{i/e}$	$M_{i/p}$	$M_{i/e}$	$M_{i/p}$	
UC	26.8	24.2	2.4	96.936	734	97.670
PC50	9.8	9.4	0.4	37.541	115	37.656
PC100	26.4	25.3	1.1	101.003	340	101.344
Treatment	Second experiment (2010)					
	P_p (t ha ⁻¹)	P_c (t ha ⁻¹)		R_t (R\$ 1,00)		Total
		$M_{i/e}$	$M_{i/p}$	$M_{i/e}$	$M_{i/p}$	
UC	18.9	15.6	3.4	57.573	1.023	58.596
PC50	17.8	15.4	2.4	56.894	734	57.628
PC100	30.9	27.0	3.9	99.797	1.169	100.967

Table 4 - Economic evaluation of the grape variety *Festival*, based on physical productivity (P_p), economic productivity (P_e), total cost (C_t), benefit/cost ratio ($R_{b/c}$), leveling point (P_n) and margin of safety (M_s).

Treatment	First experiment (2009)					
	P_p (t ha ⁻¹ year ⁻¹)	P_e (R\$ 1.00)	C_t (R\$ 1.00)	$R_{b/c}$	P_n (t ha ⁻¹ year ⁻¹)	M_s
UC	26.8	97.670		2.44		-0.55
PC50	9.8	37.656	43.800	0.89	10.9	0.16
PC100	26.4	101.344		2.41		-0.57
Treatment	Second experiment (2010)					
	P_p (t ha ⁻¹ year ⁻¹)	P_e (R\$ 1.00)	C_t (R\$ 1.00)	$R_{b/c}$	P_n (t ha ⁻¹ year ⁻¹)	M_s
UC	18.9	58,596		1.41		-0.26
PC50	17.8	57,628	44,100	1.38	11.9	-0.23
PC100	30.9	100,967		2.37		-0.56

treatment (12.6%), while in PC50 and UC treatments were 13.7% and 21%, respectively. In general, the PC100 treatment, as compared to the other treatments, contributed to the increase in productivity and defects reduction. The PC100 treatment generated favorable microclimate conditions (Leitão *et al.*, 2017) to increase productivity, which provided that this treatment had the highest total revenue for all treatments.

The productivity values, revenues, costs and economic indices presented in Table 4 indicate that the change in rates (benefit/cost and safety margin) reflects productivity differences resulting from the different treatments. They are analyzed separately considering the economic income rather than revenue based on physical productivity. For the first experimental campaign (2009), the benefit/cost was proportional to productivity, with the highest value (2.44) obtained on UC treatment. This means that for every R\$ 1.00 invested in the total cost of this treatment, there was a return of R\$ 2.44. For the PC100 treatment, the benefit/cost was very close (R\$ 2.41); and, for the PC50 treatment was significantly reduced by R\$ 0.89. As a result, the margin of safety for the PC50 treatment showed the worst index (0.16) (Table 4), indicating that the coverage positioned 50 cm above canopy height had economic productivity below the leveling point. Thus, the PC50 treatment was economically deficient, i.e., so that it equaled the revenues to costs; the sale price of grape kilograms should be 216% higher than the average market price practiced at the time (2009). The highest safety margins were cleared in UC treatment (-0.57) and PC100 (-0.55), an adjustable safety belt concerning fluctuations in the price of grape practiced by the market kilogram. Therefore, any price drop in the grape kilogram that does not exceed 57% and 55%, respectively, still maintain the economic viability of PC100 and UC treatments. Therefore, the results of this first experimental campaign indicate that the PC50 treatment presented itself as an uneconomic cultivation alternative, while the UC and the PC100 treatments have proved to be economically viable.

For the second experimental campaign (2010), the indexes “benefit/cost” and “margin of safety” were analyzed separately (Table 4) and reflect productivity differences resulting from the treatment discovered and covered with plastic sheeting. In this case, the total revenue was calculated based on economic revenues not considering 100% of real productivity and based on a single average selling price, a factor that must be considered when assessing interpretation to economic results. Thus, the benefit/cost varied in proportion to productivity, the most significant amount determined in the PC100 treatment. Therefore, for the PC100 treatment, for every R\$ 1.00 invested was calculated a return of R\$ 2.37, which is 43.2% higher than the average calculated for the UC and PC50 treatments. For safety margin values were determined PC100 = -0.56, UC = -0.26, and PC50 = -0.23, indicating that even with a reduction of up to 56% in the average grape price, the PC100 treatment would still have revenue equal to the costs. For the other two treatments, the margin on average would drop to 24%. These results indicate that treatment with plastic sheeting positioned at 100 cm above canopy height was the only alternative economically viable of the three treatments studied. These results may be related to prevailing climatic conditions during the second cultivation period, which showed little cloudiness and higher temperatures (Leitão *et al.*, 2017), causing more favorable conditions for the development of the plant in the PC100 treatment than that found in the PC50 treatment.

The indices shown in Table 5 indicate that in the second experiment (2010) for trading done in the “begging bowl”, the PC100 treatment compared with the UC and PC50 treatments appeared to be an alternative economically very viable. Therefore, as discussed in the analyses carried out based on Table 4, the prevailing climatic conditions associated with marketing method, showed that the treatment PC100 was economically more profitable. Thus, considering the scenario 2 (Table 5), the total revenue for the PC100 treatment (R\$ 104,557.98) was 41.1% exceeded the average income calculated for UC and PC50 treat-

Table 5 - Total revenue from one hectare of grape variety *Festival*, based on scenario 2, for the discovered (UC), covered (PC50) and (PC100) treatments, calculated for the second experimental campaign in 2010, in Petrolina-PE.

Treatment	P_p (t ha ⁻¹)	P_e (t ha ⁻¹)		R_t (R\$)		Total
		$M_{i/e}$	$M_{i/p}$	$M_{i/e}$	$M_{i/p}$	
UC	18.9	16.7	2.3	61,683.41	689.78	62,373.19
PC50	17.8	16.3	1.5	60,352.90	453.66	60,806.56
PC100	30.9	28.0	2.8	103,705.31	852.67	104,557.98

ments (R\$ 61,589.88). These results show that the physical productivity of PC100 (30.9 t ha⁻¹) was decisive in obtaining this increased revenue since the income established with sales to the vinegar industry and peddlers, which paid only R\$ 0.30/kilogram of grape, were practically insignificant.

4. Conclusions

The evaluation of the influence of the plastic cover on productivity and economic profitability of table viticulture in the São Francisco River Valley region shows that:

1. The plastic cover positioned at 100 cm above canopy (PC100) treatment provides a higher supply of radiative fluxes, higher physical productivity and fewer severe and mild defects in bunches and berries, creating a higher total revenue;
2. By contrast, the plastic cover positioned at 50 cm above canopy (PC50) treatment, a traditional practice adopted in the region, provides a lower supply of radiative fluxes, more significant amount of severe and minor defects in bunches and berries, resulting in sharply lower productivity, lower total revenue, and economic damage;
3. The benefit/cost ratio ($R_{B/C}$) is directly affected by climatic conditions generated by the coverage position above the canopy, since the average benefit/cost of treatment PC100 ($R_{B/C} = 2.39$) is more than twice that of PC50 treatment ($R_{B/C} = 1.13$) and about 20% over that of treatment without cover ($R_{B/C} = 1.92$). Therefore, concerning the margin of safety, the PC100 treatment performs better, and it is the most economically viable among treatments.

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